The impact of alterations in lignin deposition on cellulose organization of the plant cell wall

Jiliang Liu[1,2], Jeong Im Kim[3], Joanne C. Cusumano[3], Clint Chapple[3], and Lee Makowski[4,5]

1. Department of Electrical and Computer Engineering, Northeastern University
2. Present Address: Brookhaven National Laboratory
3. Department of Biochemistry, Purdue University
4. Department of Bioengineering, Northeastern University.
5. Department of Chemistry and Chemical Biology, Northeastern University.

Coordination of assembly of polymeric components of cell walls is essential for plant growth and development. Given the degree of co-mingling among cell wall polymers, cellulose organization must surely be dependent on the organization of other polymers such as lignin. Here we study that codependency by investigating the structural organization of cellulose fibrils in stems from Arabidopsis plants with altered lignin biosynthesis. Scanning X-ray microdiffraction was used to study cellulose architecture in the various tissues of the stem.

Several mutations—most notably those exhibiting cell walls deficient in lignin exhibited significant decrease in the proportion of oriented cellulose fibrils. Distinctions between tissues were maintained in all variants and even in plants exhibiting dramatic changes in cellulosic order, the trends between tissues (where apparent) were generally maintained. The resilience of cellulose to degradation was investigated by analysis of samples stored in water for 30 days prior to data collection.

This work demonstrates that changes in lignin biosynthesis lead to significant disruption in the orientation and order of cellulose fibrils in the stem. These dramatic phenotypic changes, in mutants with lignin rich in aldehyde or H-units, correlate with the impact the mutations have on the enzymatic degradation of the plant cell wall.